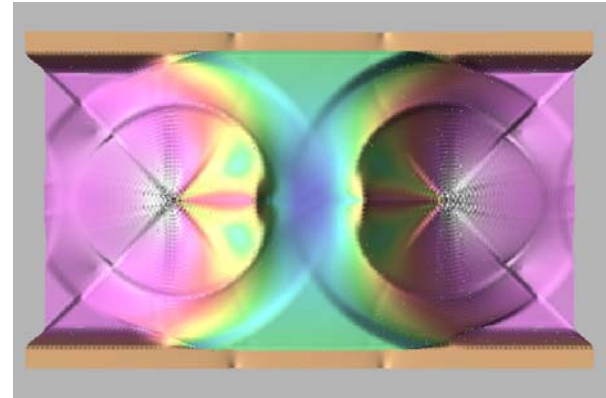


# Spacetime Discontinuous Galerkin Methods for Hyperbolic Problems in Physics and Engineering

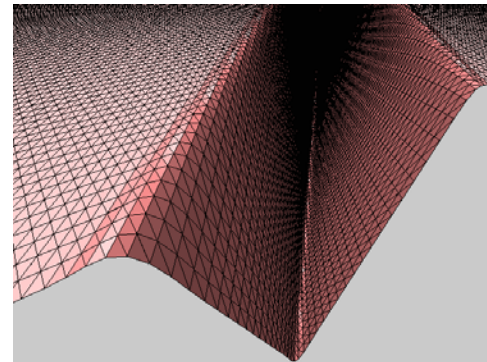
Robert Haber, Jeff Erickson, Michael Garland, Robert Jerrard, John Sullivan  
and Laxmikant Kale, University of Illinois, CPSD, DMR-0121695

## Research:

Scientists and engineers use hyperbolic balance and conservation laws to describe a broad range of physical phenomena, from the Schrödinger equation that governs quantum mechanics to the elastodynamic wave equations that describe the structural response and seismic techniques for oil exploration. Hyperbolic systems are among the most difficult to simulate numerically, especially when shocks are present. Spacetime discontinuous Galerkin (SDG) finite element methods are a new class of high-resolution simulation methods for hyperbolic problems. The images show SDG simulations of crack-tip wave diffraction and a perfect non-reflecting boundary condition. Extensions of the SDG framework for coupling atomistic and continuum models are under investigation.



**SDG simulation of elastodynamic wave scattering by a pair of crack tips subjected to shock loads.**



**Perfect non-reflecting condition on a spacetime domain boundary.**

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## **Interdisciplinary Research and Graduate Education:**

This project is an interdisciplinary research effort that involves faculty in applied mechanics (R. Haber), mathematics (R. Jerrard, J. Sullivan), and computer science (J. Erickson, M. Garland, L. Kale). In addition to fostering new faculty collaborations, the project is training a new generation of scientists in cross-discipline research. Graduate students who participate in weekly team meetings include (B. Petracovici, K. Jegdic; Mathematics), (J. Palaniappan, R. Abedi, M. Hawker, Y. Fan, C. Xia; Theoretical & Applied Mechanics), (J. Booth, S.-H. Chung, M. Hills S. Thite,

Y. Zhou; Computer Science). One postdoc in mathematics (Y. Ko) recently left the project to join the faculty at California State University at Bakersfield.

## **Undergraduate Education:**

One undergraduate student in computer science (C. Wojtan) received summer research training by working on visualization methods and per-pixel rendering techniques for our spacetime data sets.